Engineering Note 310
May 1999

Magnetic Field Intensity Measurements on Telephone Receivers Using CCL's Measurement Probes

CCL's measurement probes, HAC-R100 and HAC-A100, have been designed to assist manufacturers in the evaluation of telephone handset receivers according to the requirements given in 47 CFR, Part 68, Section 68.316. These requirements specify the minimum magnetic field intensity measurements necessary for a telephone receiver to be considered hearing aid compatible. This engineering note describes a test procedure that can be used to produce a consistent evaluation of telephone receivers.

The measurement probes are constructed to tolerances of ±0.5 mm. For most equipment this should be adequate to produce consistent results. However, some receivers produce a magnetic field with extreme variations. In some cases, it may be difficult to make a consistent measurement. If the equipment is marginally close to the HAC limits, measurement inconsistency may make it impossible to determine if the equipment is hearing aid compatible or not.

There are two major causes of measurement error. The first source of measurement error is due to probe manufacturing tolerances. This error is reduced by averaging several different readings, as described in the procedure below. The second source of error is due to operator inconsistencies. By using an established test procedure, this error may be greatly reduced. Using the test procedure described in this engineering note, it should be possible to reduce measurement error to ±0.5 dB.

Axial Field Intensity Measurements

The first measurement that should be made on a telephone receiver is the axial field intensity measurement. Other measurements will be based on the results of this measurement.

The axial probe, HAC-A100, is inscribed with a circle at a radius of 10 mm from the center of the probe. This circle is inscribed on just one side of the probe. The probe is also labeled. The label should be attached to the same side of the probe as the inscribed circle. This side will be called the "printed side" of the probe. As shown in Figure 1, "normal orientation" of the probe, during a magnetic field intensity measurement, is when the probe is positioned on the telephone receiver with the printed side up, or away from the telephone receiver. "Reverse orientation" is when the probe is positioned on the telephone receiver with the printed side down, or next to the telephone receiver.

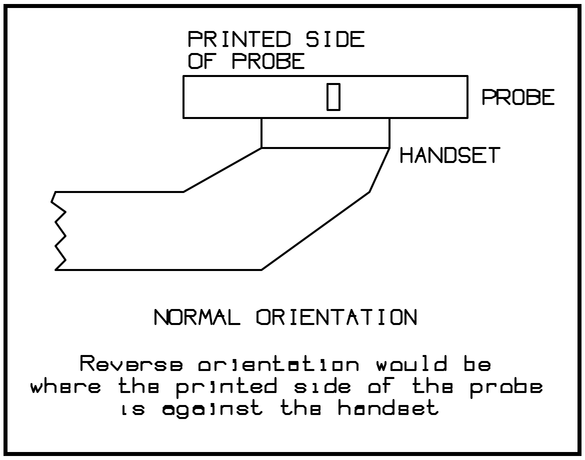

Figure 1

The axial measurement is made by placing the probe on the telephone receiver in the normal orientation. The probe should be placed flat against the telephone receiver. If the receiver has a concave shape, the probe will contact the outer edges only. The center of the probe is indicated by a small indentation on the inscribed side of the probe. The probe center should be aligned with the axial center of the telephone receiver. A search is then made for an axial field intensity maximum. This is done by moving the probe up to 10 mm away from the axial center of the telephone receiver, in all directions. In practice, this can be accomplished by simply moving the probe around so that an imaginary line through the telephone receiver axis touches all points within the inscribed circle on the probe. The circle has been inscribed so that the outer edge of the circle is 10 mm from the probe center.

Once the location of maximum axial field intensity has been identified, this point should be marked on the telephone receiver so that it can be used as a reference point for subsequent measurements. An imaginary line through this reference point is called the measurement axis. The measurement axis is parallel to the telephone receiver axis, but not necessarily the same. Once the measurement axis has been identified, the probe is again placed on the telephone receiver in the normal orientation with the probe center at the measurement axis. The probe coil signal voltage is then measured (in dBV). The axial field intensity measurement for the normal orientation is then calculated by adding the correction factor for the probe.

The probe is then placed on the telephone receiver in the reverse orientation (printed side next to the telephone receiver) with the probe center aligned with the measurement axis. The probe coil signal voltage is then measured (in dBV) and the field intensity calculated by adding the correction factor. Axial field intensity for the telephone receiver is then calculated as the average of the normal orientation field intensity reading and the reverse orientation field intensity reading. Expressed mathematically, the axial field intensity is calculated from the two voltage measurements as

$$Axial\ Field\ Intensity = \frac{\left(V_N + CF\right) + \left(V_R + CF\right)}{2}$$

where V_N is the probe coil voltage in the normal orientation (in dBV), V_R is the probe coil voltage in the reverse orientation (in dBV), and CF is the correction factor for the probe (in dB).

Averaging these two measurements, the normal orientation measurement and the reverse orientation measurement, compensates for probe coil positioning errors that may occur when the coil is not positioned precisely at a height of 10 mm above the measurement plane.

Radial Field Intensity Measurements

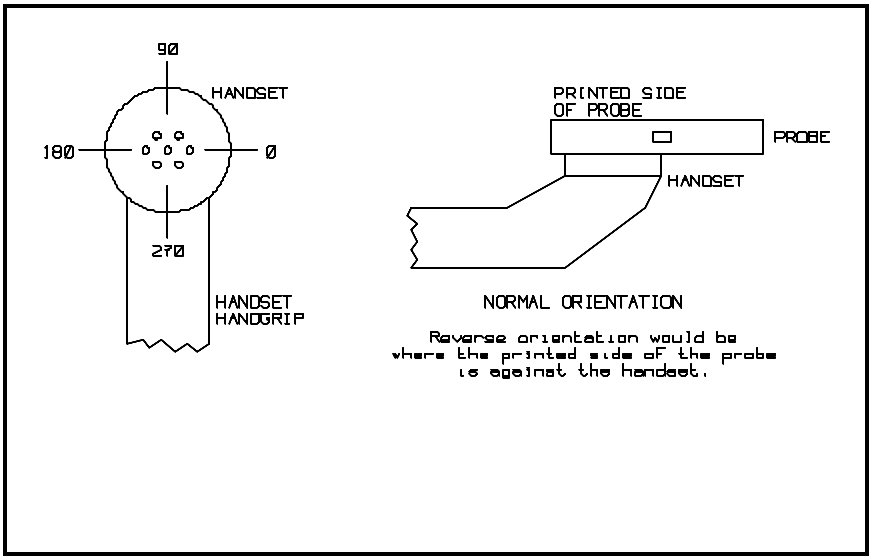

Figure 2

Like the axial probe, the radial probe, HAC-R100, is inscribed with a circle on one side of the probe. The radial probe is also labeled, with the label being properly attached to the same side of the probe as the inscribed circle. As with the axial probe, this side will be called the “printed side” of the probe. As shown in Figure 2. “Normal orientation” of the radial probe, during a magnetic field intensity measurement, is when the probe is positioned on the telephone receiver with the printed side up, or away from the telephone receiver. “Reverse orientation” is when the probe is positioned on the telephone receiver with the printed side down, or next to the telephone receiver.

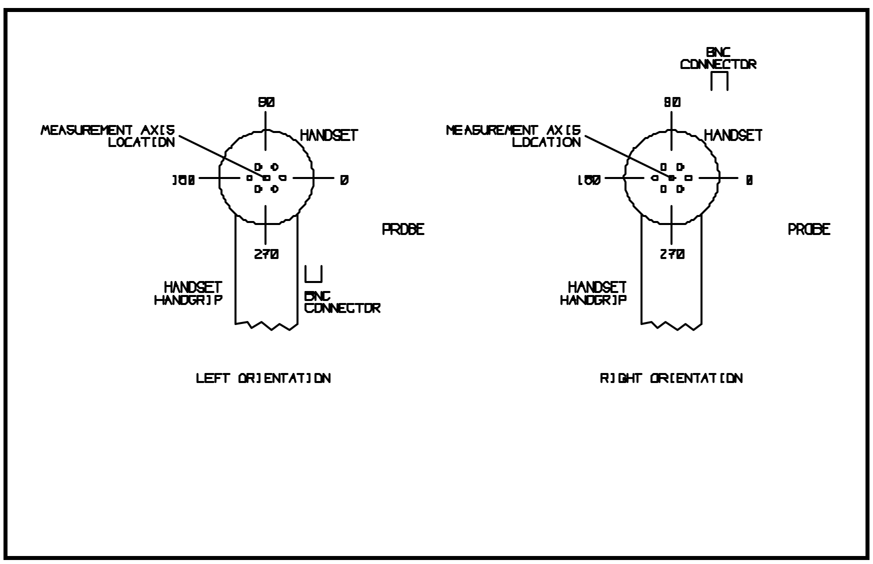

Figure 3

An additional distinction is made between left and right orientations. As shown in Figure 3, “left orientation” is when the measurement axis is to the left of the probe center. Left and right on the probe are determined by the position of the probe’s BNC connector. “Right orientation” is when the measurement axis is to the right of the probe center.

The radial measurement is made by placing the probe on the telephone receiver in the normal/left orientation. The probe should be placed flat against the telephone receiver. If the receiver has a concave shape, the probe will contact the outer edges only. The probe coil axis is indicated by a line inscribed across the probe surface. The probe coil axis should be aligned with the appropriate radial direction (0E, 90E, 180E or 270E), with reference to the measurement axis. The radial measurement should not be made with reference to the telephone receiver center axis, unless, of course, the telephone receiver axis and the measurement axis happen to coincide. The field intensity reading for this orientation is then made by positioning the center of the probe 16 mm away from the measurement axis and then recording the maximum probe coil voltage as the probe is moved slowly away from the measurement axis, in the specified radial direction. The circle has been inscribed so that the outer edge of the circle is 16 mm from the probe center. The radial field intensity for this orientation is then calculated by adding the probe correction factor (in dB) to the measured probe coil voltage (in dBV).

This process is then repeated, with the probe in the normal/right orientation (printed side away from the telephone receiver, measurement axis to the right of the probe center); then again with the probe in the reverse/left orientation (printed side next to the telephone receiver, measurement axis to the left of the probe center), and finally with the probe in the reverse/right orientation (printed side next to the telephone receiver, measurement axis to the right of the probe center). Radial field intensity for the specified radial direction is then calculated as the average of the normal/left orientation measurement, the normal/right orientation measurement, the reverse/left orientation measurement and the reverse/right orientation. Expressed mathematically, the radial field intensity is calculated from the four voltage measurements as

$$Radial\ Field\ Intensity = \frac{\left(V_{NL} + CF\right) + \left(V_{NR} + CF\right) + \left(V_{RL} + CF\right) + \left(V_{RR} + CF\right)}{4}$$

where V_{NL} is the probe coil voltage in the normal/left orientation (in dBV), V_{NR} is the probe coil voltage in the normal/right orientation (in dBV), V_{RL} is the probe coil voltage in the reverse/left orientation (in dBV), V_{RR} is the probe coil voltage in the reverse/right orientation (in dBV), and CF is the correction factor for the probe (in dB).

Averaging these four measurements compensates for probe coil positioning errors that may occur when the coil is not positioned precisely at a height of 10 mm above the measurement plane with the coil centered precisely at the probe center.

Induced Voltage Frequency Response

The induced voltage frequency response test plots the telephone receiver’s response at frequencies from 300 Hz to 3300 Hz relative to the response at 1000 Hz. Consequently, errors caused by probe positioning and operator error are essentially eliminated. As long as the probe is in roughly the proper location and is not moved during the sweep, consistent results are easily achieved. If the probe is moved during the test, consistent results may be more difficult to achieve.

The induced voltage frequency response measurement is made by placing the axial probe on the telephone receiver in either the reverse or normal orientation. The probe should be placed flat against the telephone receiver, as described in the axial field intensity measurement. The center of the probe should be located at the reference axis. The probe coil signal voltage is then measured at frequencies from 300 Hz to 3300 Hz. The probe coil signal voltage is then plotted with respect to the level at 1000 Hz and compared to the specified limits. There is no need to apply a correction factor, since all readings are relative. The frequency response of the probe is taken into account by the frequency response mask.